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* Recent increased interest in the sedimen- *
* tation test for wheat quality makes it *
* desirable that a nontechnical explanation *
* of the test be provided for the grain *
* trade. This publication is intended to *
* serve as that explanation. *
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WHEAT STRENGTH and the SEDIMENTATION TEST

By Lawrence Zeleny

Wheat Strength. Strong wheats are those that yield flours capable of producing bread of large loaf volume and superior internal characteristics. Weak wheats yield flours that will produce bread of small loaf volume and unsatisfactory internal characteristics. Weak wheats, however, are usually superior to strong wheats for the production of cake, cookie, cracker, and pastry flours.

The baker does not usually want the strongest possible flour for bread baking. Therefore, the miller in producing bread flour usually uses a moderately strong wheat or a blend of a strong wheat with weaker wheat to obtain the strength in his flour the baker desires. Nevertheless, the supply of relatively weak wheat in the United States and throughout most of the world is considerably greater than the supply of strong wheats. For that reason strong wheat is in great demand and usually commands a considerable premium over weaker wheat in U.S. and world markets. U.S. hard wheat farmers are being urged to grow strong varieties and hard wheat breeders are emphasizing the importance of strength in their breeding programs. Practical methods for estimating wheat strength are greatly needed as aids in the marketing of wheat.

Sedimentation tests of weak (left) medium and strong wheats

Strength of wheat may depend on a number of factors but the most important of these are protein (or gluten) content and gluten "quality." Although strong wheats are generally considered to be those of high protein content, wheat of high protein content is sometimes much weaker than expected because of a weakness in its gluten. Gluten quality depends both on variety and climatic conditions during growth.

Wheat strength is best measured by carefully controlled milling and bread-baking tests, using a baking method that is sensitive to small differences in strength. The bread volume is then used as a measure of strength. Baking tests are impractical for use in routine wheat inspection because of the time required, the expense of equipment, and the lack of sufficient objectivity in the tests.

The Farinograph, Mixograph, Alveograph, and other mechanical dough testing devices are also used to indicate wheat strength. Mechanical dough testing devices yield much information of value to the baker but are of limited value in measuring actual strength. Also, this type of equipment has not been adequately standardized.

The Sedimentation Test. The sedimentation test has been designed as a simple and rapid way to estimate the strength of wheat. It does not require the elaborate milling equipment usually needed for bread-baking or dough-mixing tests. The test may be completed in 15 minutes or in an average time of about 5 minutes when a number of tests are made simultaneously. The equipment required is relatively simple and inexpensive. When all details of the procedure are followed, there is no serious difficulty in obtaining good agreement among different operators making the test.

The test is based on the known facts (1) that gluten protein absorbs water and swells enormously when treated with lactic acid under certain conditions, and (2) that the amount of water absorbed and consequently the extent of swelling depends on the "quality" of the gluten. Good quality gluten (from a bread-baking standpoint) absorbs more water and thus swells more than poor quality gluten.

In making the sedimentation test, a crude white flour is first made by grinding and sieving about 200 grams of wheat, using prescribed equipment and procedures. A small weighed portion of the flour is mixed with water and a lactic acid reagent in a glass cylinder. The cylinder is then allowed to stand for exactly five minutes. Then the volume of the "sediment" in the cylinder is read in milliliters. The volume of the sediment depends largely on the quantity of gluten in the wheat and the extent to which the gluten is swollen (gluten quality). The test, therefore, is a combined measure of the quantity and quality of gluten which, as stated, are the principal factors involved in wheat strength. The sedimentation test should, therefore, be a better measure of wheat strength than any test which measures only gluten quantity or gluten quality alone.

Thousands of comparisons have been made between sedimentation values and bread-baking tests over a period of years and highly significant correlations have nearly always been found when straight-dough bread-baking tests were used. Although the sedimentation test cannot be considered to be a wholly accurate test for wheat strength, all evidence available indicates that it usually provides a better measure of the overall bread-baking strength of wheat than any other known test except an actual bread-baking test.

Sedimentation values range from about 3 for very weak wheat up to about 70 for the strongest wheat. Following is a suggested classification of wheat based on sedimentation values, including general statements concerning the characteristics of wheat in each range:

1. Sedimentation values of 60 and over. This wheat consists almost entirely of hard wheat (other than durum wheat) and is nearly always of high protein content, usually over 14 percent, and of superior gluten quality. It has superior baking strength and is suitable for mixing with weaker wheat for the production of bread flour, or for milling the very strong flour demanded by a small segment of the bread-baking industry. In normal years this type of wheat is in short supply and commands a considerable premium. Hard wheat of recognized weak varieties rarely, if ever, falls into this range.

2. Sedimentation values of 40 to 59. This wheat consists almost entirely of hard wheat (other than durum wheat) and is of the type most widely used for production of bread flour. The protein content of the wheat is usually from 12 to 14 percent, and the quality of the gluten is usually good. Hard wheat of recognized weak varieties falls into this range only when of very high protein content and consequently of at least reasonably high bread-baking strength.

3. Sedimentation values of 20 to 39. This wheat consists largely of low protein content hard wheat such as that produced east of the Mississippi River and on the Pacific Coast. Hard wheat of recognized weak varieties, even though of fairly high protein content, as well as some soft wheats of the highest protein content, also fall into this range. Included also in this range is hard wheat that has suffered gluten injury as a result of unfavorable weather conditions prior to harvest. Wheat in this range is best suited to the production of "all-purpose" flour or for use in mixing with stronger wheat for the production of bread flour.

4. Sedimentation values of less than 20. This wheat consists almost entirely of soft wheat but may contain some hard wheat of exceptionally low protein content or exceptionally weak gluten quality. The wheat is used primarily for the production of cake, pastry, cookie, and cracker flours.

From left to right, loaves of bread made from weak, medium, and strong wheat flours.

The sedimentation test is being used successfully by a number of U.S. flour mills for binning and blending bread wheats and is also being used by most flour mills in West Germany. The test is said to be used as the basis for binning wheat in Western Australia. It is probable that increased use of the sedimentation test may soon be made in filling contracts of foreign buyers of U.S. wheat as a result of persistent complaints regarding poor and nonuniform baking strength of hard wheat from the United States.

Details of the procedure for making the sedimentation test are published in Cereal Chemistry, Volume 34, pages 16-25 (1957), and in Cereal Laboratory Methods, published by the American Association of Cereal Chemists, 1955 University Avenue, St. Paul 4, Minnesota.

Additional technical information concerning the sedimentation test may be obtained from the Grain Division, Agricultural Marketing Service, U.S. Department of Agriculture, Washington 25, D.C. or from the published reports in the following bibliography:

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